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PREVALENCE AND SEVERITY OF BACTERIAL SOFT ROT IN COMMONLY GROWN POTATO VARIETIES IN NYANGA DISTRICT, ZIMBABWE

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Potato (*Solanum tuberosum* L.) production in Zimbabwe is an important element of the agricultural production sector. The local industry is however affected by low yields due to soft rot disease (*Pectobacterium carotororum* subsp. *carotovorum)* and poor quality produce. The main thrust of this study was to come up with recommendations that would increase potato production through improved knowledge of cultivar choices according to ranked performance in terms of soft rot infestations. Four experiments were conducted, in the field; in greenhouse, in storage at 10°C and at room temperature on soft rot inoculated and un-inoculated potato tubers. The experiments were conducted on five locally available varieties in Zimbabwe. Tubers were screened for soft rot infection using counts and weights of infected tubers and BP1 showed significant difference ($p<0.05$) in terms of soft rot infestation on counted tubers. The field experiment treatments of Amethyst, Mnandi, BP1, Montclare and Jasper were laid in Randomized Complete Block Design (RCBD). The Area under Disease Progress Curve (AUDPC) for potato late blight recorded was highest for BP1 (10.04%) and least for Jasper (6.81%). Amethyst and BP1 varieties recorded the highest (5.0%) incidence for tuber soft rot. The greenhouse pot experiment had five soft rot inoculated and un-inoculated potato tubers and treatments were laid in Complete Random Design (CRD). Percentage emergence for inoculated pots dropped by more than 75% relative to the un-inoculated plot for BP1, Montclare and Mnandi varieties. Amethyst recorded a 100% drop in germination for the inoculated plots. Mnandi had the highest (41.37%) proportion of tubers from small and below grade. On the other hand, variety BP1 had the highest (80.01%) proportion of tubers from medium size and above. Tuber yield was highest for Jasper (34.01t/ha). This study shows that BP1 variety rank in the potato seed certification industry needs to be revised according to soft rot tolerance to update previous ranks of the cultivar. Farmers are advised to adopt new varieties and have reliable seed sources.
Keywords: Variety, disease incidence, potato, soft rot and tuber yield

INTRODUCTION

In Zimbabwe, potato is increasingly becoming a major food and cash crop but production continues to be hampered by pathological and physiological problems (Ngadze *et al*., 2012). It is also constrained by the carry-over of pathogens and physiological degradation (Mutetwa *et al.,* 2010). Potato tubers being nearly 80% water, they are especially susceptible to bacterial pathogens that cause soft rot, resulting to losses of up to 90% in the field and in storage (Czajkowski *et al*., 2011a).
In potato, *Pectobacterium* and *Dickeya* genera cause wilt, soft rot, and blackleg and affect plant health during field production and storage (Pe´rombelon, 2002). Tuber soft rot and aerial stem rot often occur after plants are wounded by tools, poor handling, insects and severe weather such as hail. Although infested potato residues and rotting tubers are among the important sources of inoculum, latent infections in seed tubers provide the major source of infection in potato production (van deh Wolf and Bergsma Vlami, 2013). In Zimbabwe, potato growers face the challenge of significant post-harvest losses of tubers ranging from 20 to 80% (Ngadze, 2010) leading to significant financial losses. Yield losses of up to 90% as a result of planting diseased seed have been recorded (Ngadze *et al*., 2012).
The presence and or absence of varietal tolerance or partial resistance to soft rot causing bacteria among the cultivated commercial varieties have not been established in Zimbabwe. Ranking of cultivars for resistance and tolerance to tuber soft rot is a key to improving growers' decision making process with regards to disease management strategies. Growers are encountering varying magnitude of losses due to these bacterial pathogens which are further amplified by poor storage, handling and agronomic practices (Elphinestone, 1987; Pe´rombelon, 2002; Ali *et al*., 2010; Czajkowski *et al*., 2011b, 2015; Ngadze *et al*., 2012; Mantsebo et *al*., 2014; Onkendi and Moleleki, 2014).
Sustainable seed and ware potato production in Zimbabwe hinges on effective integrated disease management approaches to reduce the effects of these bacterial pathogens

(Ngadze, 2010). Information on varietal differences with regards to bacterial soft rot tolerance is scant. In view of the knowledge gap on varietal differences in tolerance to soft rot for which no effective chemical control exists, this study provides a platform for initiation of further research on future breeding strategies and integrated disease management programs for bacterial soft rots.

The evaluation and identification of bacterial soft rot tolerance is important for purposes of germplasm conservation and genetic diversity assessment for future breeding. This study also was carried out to evaluate the incidence and tolerance of bacterial soft rot in different potato varieties grown in Zimbabwe.

MATERIALS AND METHODS

Site Description and Experimental Designs: ***Survey:*** A survey was conducted in the Quarantine farming area of Nyanga district in Manicaland Province, Zimbabwe. The Quarantine area is sited in Natural Region Ia with an altitude of 2,100m above sea level. The mean annual rainfall ranges from 800-1000mm. The mean annual temperature ranges from 15-27^{o}C. The soil type is predominantly red clay.

A sample of nine farmers was chosen at random in the area under investigation. A questionnaire was administered to the individual farmers and face to face interview were conducted. Data relating to farmers' general experience with bacterial soft rots and its economic impact on potato production management strategies were collected. Samples of five different potato varieties; Amethyst, Jasper, Mnandi, BP1 and Montclare were collected based on availability. The tubers were brought to the Africa University laboratory where biochemical analysis of soft rot was done. A physical count of the tubers was done in the laboratory. Damaged tubers were separated from healthy ones. For each variety, damaged potato tubers showing signs of soft rot were separated, counted and recorded against the healthy potato tubers. A percentage of infection was noted against healthy ones.

Greenhouse Experiment: The experiment was carried out at the Africa University Farm at the Horticulture section. Seed potato varieties used for the inoculated treatment were Amethyst, BP1, Mnandi, Montclare and Diamond. The un-inoculated treatment was planted to Amethyst, Mnandi, BP1, Montclare and Diamond varieties. The potting media used for both treatments was sterilized against any pathogens in an autoclave. Two tubers of each variety were planted in a 5kg black plastic pot filled with the potting media. All the treatments were replicated three times. The pots were placed on the concrete floor of the greenhouse and irrigated manually using a watering can. The germination assessment was conducted two weeks after planting**.**

Preparation of the Inoculants for the Tubers and Testing for Soft Rot Presence: Potato tuber portions infested with soft rot bacteria were cut and washed with distilled water. The infested portions were ground using a kitchen blender and the inoculum was plated with the supposed soft bacteria in nutrient agar. The samples were left in the laboratory under sterile conditions for 48 hours at 25^{o}C. The bacterial colonies from the nutrient agar were isolated and multiplied and incubated for 24 hours (Plate A and B). Potato tuber slices were cut at 7-8 mm aseptically. The slices were placed on moistened, filter paper in a petri dish. A nick was made in the center and bacterial growth for *Pectobacterium* inoculum was placed on the slice nick point. The soft rot test was graded positive as symptoms and characteristics of soft rot bacteria were observed on inoculated tuber slice as shown in (Plate C). The tubers were inoculated by dipping in the suspensions of soft rot bacterium concentration (200ml inoculum: 2l water), for 30 minutes and air-dried separately.

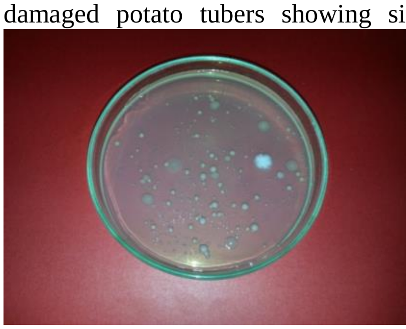

Plate A.

Plate B.

Plate C.

Field Experiment: A trial was set up at Africa University Farm, Mutare Zimbabwe during the 2014-2015 farming season. The area is under agro ecological region 2 (18º53'70, 3" S: 32º 36'27'9"E) at an elevation of 1131 m above sea level. The soils are classified as sandy clay loam of the red Fersiallitic 5E series under Zimbabwe soil classification (Nyamapfene, 1991). Five varieties; Amethyst, Montclare, Mnandi, Jasper and BP1 were evaluated for soft rot varietal tolerance in a field experiment laid out in a Randomized Complete Block Design (RCBD) with three replicates. The distance between blocks was 1metre and the distance between plots in a block was 1 meter. Each plot was 4 x 3m with 4 rows. Each row had 10 plant stations spaced at an inter-row spacing of 0.90m and an in-row spacing of 0.30m. A potato border crop was planted right round the experimental field. Compound D ($7N:14P_2O_5:7K_2O$) was applied as a basal dressing at a rate of 1500kg ha^{-1} and one tuber was planted at each planting station. Weeding was done by hand hoeing. Top dressing using ammonium nitrate at a rate of 300kg ha^{-1} was split applied twice.

Data Collection: Survey data was collected by administering a questionnaire to respondents based on the

educational qualifications; soft rot control methods, soft rot knowledge, potato cultivar preferences and cultivar ranks, water sources and irrigation method used by farmers. Field experiment data was collected on germination %, AUDPC for Early light, yield, tuber size and incidence of soft rot.

***Data analysis**:* Data from the survey were analyzed using SPSS version 16.0 while data from the field experiment and screening were analyzed using GenStat version 5 statistical packages. The data were subjected to analysis of variance (ANOVA) and the means of the parameters were separated using the least significant difference (LSD) at P=0.05. Data from the green house experiment were analyzed using GenStat version 5 (t-test statistic) to compare inoculated and un-inoculated tuber parameters.

RESULTS

Survey

***Demographic Characteristics of the Respondents**:* This section presents the general demographic attributes of the sample respondents. This picture is critical as it provides an insight into the nature of distributions across variables such as age, gender, marital status and education level of respondents. Of the nine farmers interviewed, 89.0% of the respondents were male and 11.0% were female. With regards to educational level, 44.4% of the farmers obtained secondary education and 22.2% reached diploma level of education. Some 33.3% had University qualification (Fig. 1).

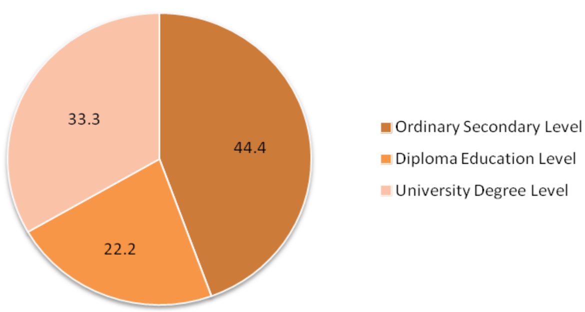

Figure 1: Level of Education attained by farmers.

All farmers were interested in participating in knowledge training of soft rot disease. All the farmers use natural seed store temperatures to manage the soft rot disease. None of the farmers has and/or use neither cold rooms nor modern potato seed stores structures at their farms. No specific disease management has been adopted by these farmers. The survey also revealed that 55.6% of farmers use cultural control methods such as domestic disinfectants or sanitation. On the other hand, 44.4% of farmers do not practice any soft rot control method (Fig 2).

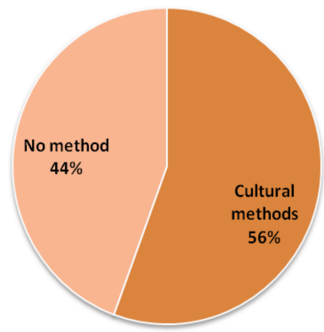

Figure 2: Distribution of methods used by farmers against soft rot

Three groups of farmers were questioned about their cultivar preferences. All groups had 33.3% preferences of the varieties they grow from the total population of farmers interviewed (Table 1). The three groups of farmers ranked their preferences of potato cultivars in relation to tolerance to soft rot disease. The farmers that prefer to grow Amethyst, Garnet, Jasper, Diamond, BP1, and Montclare were 77.0 and 23.0% preferred to grow Mondial and Mnandi.

Table 1: Percentage of cultivars grown by respondents, ranks according to preference and pest problems experienced.

Class	Cultivars grown by respondents	Responses (%)
Group 1	Amethyst, Garnet, Jasper, Pimpernel, BP1, Montclare	33.3
Group 2	Amethyst, Garnet, Diamond, Pimpernel, BP1, Montclare	33.3
Group 3	Amethyst, Garnet, Jasper, Diamond, Pimpernel, BP1, Montclare, Mnandi	33.3

Farmers experienced problems with potato tuber moth, root knot nematode and aphids. The percentage of effect of the pest to the farmer was the same at 33.3% for all pests.

Source of irrigation water and irrigation method: Most farmers are irrigating their crops with water from the dam/weir. The proportion of these farmers is 44.4% while on the other hand only 11.1% of the farmers are using water from the borehole (Table 2). Other sources of water used for irrigation account for 44.4%. Sprinkler method accounts for 72.8% of the irrigation used by these seed potato growers while 22.2% of the farmers use the perforated pipes.

Table 2: Percentage of water source used by respondents and irrigation methods adopted

Water source	Responses (%)
Dam/Weir	44.4
Borehole	11.1
Other	44.4
Irrigation method	
Sprinkler	72.8
Perforated pipes	22.2

Quality of seed tubers collected from farmers: There was no significant difference (p>0.05) between Amethyst, Mnandi and Diamond potato varieties in terms of soft rot infection on seed tubers. There was significant difference (p<0.05) between BP1 and other varieties as BP1 showed a high infestation of soft rot infection on seed tubers (Table 3). Based on weights of screened tubers, there was no significant difference (p>0.05) for Amethyst, Mnandi, Montclair and Diamond as seed had less infected tubers when they were counted from 3 kg pockets.

Table 3: Average number and weights of infected tubers obtained from seed potato farmers in Nyanga

Variety	Average number of infected tubers	Weights (g) of infected tubers
Amethyst	0.67^{a}	0.0150^{a}
BP1	3.33^{b}	0.1133^{b}
Mnandi	1.67^{a}	0.0150^{a}
Montclare	1.33^{a}	0.0100^{a}
Diamond	0.97^{a}	0.0135^{a}
$LSD_{0.05}$	1.087	0.02015
CV %	33.0	27.9

Means followed by the same letter in the column are not significantly different from each other at P=0.05.

Greenhouse Experiment

Sprouting: The comparison of the means for the sprouting of inoculated and uninoculated treatments is shown in Table 4. The decrease in the germination of the inoculated treatment from the uninoculated treatment for BP1, Montclare, Amethyst and Mnandi varieties was 80.01, 75.21, 100 and 80.06%, respectively. The comparison for the inoculated and un-inoculated treatments for Diamond variety was not statistical significant (P>0.05). The germination percentage for plots under inoculated treatments decreased by 16.73%.

Table 4: Mean percentage of emerged tubers of inoculated and uninoculated pots

Variety	Percentage		Difference	Test statistic (t)	Probability (p)
	Uninoculated	Inoculated			
Diamond	33.30	27.73	1.00	5.567	ns
BP1	27.73	5.533	2.00	22.20	*
Montclare	22.31	5.53	1.02	16.78	*
Amethyst	27.73	0.00	4.98	27.73	*
Mnandi	27.73	5.53	2.00	22.20	*

ns denotes non statistical difference, ***** denotes significant difference at (P=0.05).

Field Experiment

Sprouting: There were significant differences (P<0.05) in data pertaining to tuber sprouting (Figure 3). Jasper recorded the highest (70.3%) sprouting percentage. The lowest sprouting percentage was recorded for BP1 (50.7%) and was not significantly different (P>0.05) to Amethyst (56.7%), Mnandi (57.7%) and Montclare (55.0%).

AUDPC for Early Blight: The comparison of the means for AUDPC indicate significant differences (P<0.05) for the varieties (Table 5). The highest AUDPC was recorded for BP1 (10.04) while Jasper (6.81) recorded the lowest. Means for Amethyst (8.12), Mnandi (8.36) and Montclare (8.10) were not significantly different (P>0.05) from each other.

Yield: Data regarding the final tuber yield shows significant differences for the varieties investigated (Table 5). The highest yield (34.01 t/ha) was recorded for Jasper. The lowest yield was recorded from Amethyst (18.58 t/ha) and Montclare (20.62 t/ha). Yields for BP1 (27.47 t/ha) and Mnandi (26.79 t/ha) were not statistically different (P>0.05) from each other.

Incidence of Soft Rot: There were significant differences (P<0.05) for both weight and tuber counts of infected tubers recorded (Table 5). The highest number of infected tubers (5.00) was recorded for Amethyst and BP1 varieties while no statistical differences (P>0.05) were noted for Jasper, Mnandi and Montclare with 1.67, 2.33 and 1.33 infected tubers respectively.

The highest weights for infected tubers were recorded for Amethyst (0.867g), BP1 (0.950g) and Jasper (1.333g) while the lowest was recorded from Mnandi (0.683g) and

Montclare (0.300g) and were not statistically different from each other.

Table 5: Germination percentages, AUDPC and yield (t/ha) and soft rot yield incidence % for 5 potato varieties

Variety	Germination (%)	AUDPC Of early blight	Yield t/ha	Incidence of soft rot on yield	
				Weights (g)	Tuber Counts
Amethyst	56.7[ab]	8.12[b]	18.58[a]	0.867[b]	5.00[b]
BP1	50.7[a]	10.04[c]	27.47[b]	0.950[b]	5.00[b]
Jasper	70.3[b]	6.81 [a]	34.01[c]	1.333[b]	1.67[a]
Mnandi	57.7[ab]	8.36[b]	26.79[b]	0.683[a]	2.33[a]
Montclare	55.0[a]	8.10[b]	20.62[a]	0.300[a]	1.33[a]
Mean	*58.08*	*8.286*	*25.49*	*0.8266*	*3.066*
$LSD_{0.05}$	14.65	1.26	4.23	0.542	1.770
CV%	13.9	8.4	32.5	12.7	10.0

Means followed by the same letter in the column are not significantly different from each other at (p=0.05)

Tuber Size: Data regarding tuber sizes and distribution for each variety is shown in Table 6. Mnandi had the highest (41.37%) proportion of tubers from small and below grade followed by Amethyst with 35.68%. The variety with the least proportion of tubers from small and below grade was BP1 (19.99%). Varieties Montclare and Jasper recorded 31.83 and 28.68% respectively. BP1 had the highest (80.01%) proportion of tubers from medium size and above, followed by Jasper (71.32%) while Mnandi recorded the least (58.63%) proportion. Variety Amethyst and Montclare had 64.32 and 68.17%, respectively.

Table 6: Percentage weights (kg) of graded tubers after harvesting

Tuber sizes	Weight in (gms)	BP1 %	Amethyst %	Montclare %	Jasper %	Mnandi %
Large	>250	31.15	8.82	22.12	16.1	11.37
Large medium	150-250	26.66	29.8	20.35	30.02	19.61
Medium	90-170	22.2	25.7	25.7	25.2	27.65
Small	50- 100	14.66	22.16	17.96	14.81	26.17
Baby	5-50	5.33	13.52	13.87	13.87	15.2

DISCUSSION

Survey: Response rate of above fifty percent for phenomenological research is sufficient enough to allow the researcher to gather valid and reliable data that is representative of the population (Fraaije *et al.,* 1997). Infected tubers were isolated from the batches of seed obtained from the farmers indicating the presence of soft rot in Nyanga. From the recorded responses, the source of the initial inoculum is difficult to ascertain as the seed potato certification scheme relies solely on visual inspection of the crop in the field and the harvested tubers. Latently infected tubers cannot be detected visually as it requires sampling and testing of seed stocks (Czajkowski *et al*., 2011b). Washing and disinfection of farm equipment used when planting, ridging, spraying, haulm destruction, harvesting and grading in store aid to reduce risks of introducing soft rot bacteria in a pathogen-free crop (Pe´rombelon, 2002). Unfortunately, farmers in Nyanga are not practicing any method to either reverse and/or arrest the spread and continuous development of soft rot bacteria during their crop production activities.

Jasper, Amethyst and Montclare were able to carry profitable yields under disease pressures. Failure of some famers to positively diagnose soft rot in the field and in storage has impeded effective control through cultural practices. Farmers' knowledge of the etiology and epidemiology is key to management of the soft rot disease complex. Such knowledge has greatly reduced occurrence of the disease in developed countries (Czajkowski *et al.,* 2011a). Studies in Scotland showed that an initially bacteria-free potato stock became progressively more contaminated after the third year in the field (Czajkowski *et al*., 2011b).

Mantsebo *et al*., (2014) also observed that contamination befalls at the time of mechanical crop handling at harvest and grading in stores. It is likely therefore that initial inoculum came from farm equipment already contaminated, although infection may result by airborne bacteria or irrigation water. Likewise, del Pilar Marquez-Villavicencio, *et al*., 2011 reported that, late and early blight as well as bacterial wilt do occur in the crop at the same time with soft rot. Existing knowledge gap among farmers need to be filled so as to reduce yield losses caused by soft rot.

Source of irrigation water and method of irrigation tend to compound the soft rot disease complex (Elphinestone, 1987). The rainfall received in the Nyanga region is adequate for potato production in a good season. Potato seed crops are only rain fed in summer to jettison irrigation water or sprinkler splash as a source and mode of spread of diseases in the crop as soft rot inoculums have been recovered from rivers, oceans and rain (Graham *et al.,* 1977; Franc *et al.,* 1986; Jorge and Harrison, 1986). Analysis of

surface water used for irrigation of potatoes has indicated contamination with soft rot microorganisms (Gudmestad and Scor, 1983; Harrison *et al*1987; McCarter-Zorner*etal*., 1984). Well ventilated seed stores used by farmers at low temperatures avoid condensation on tuber surfaces, which in turn prevent multiplication of the blackleg pathogen (Elphinestone, 1987). Soils in the Nyanga area are characteristically deep and well drained and thus reduces the risk of tubers being surrounded by a water film that can result in anaerobiosis and consequent tuber decay in the field (Fraaije *et al*., 1997). Ngadze and Icishahayo, (2014) reported that Nyanga has the lowest disease incidence of blackleg and soft rot. Incidence and severity of blackleg and soft rot also depend on temperature and free water (Pe´rombelon, 2002). Conditions optimal for blackleg and soft rot development are between 15 and 25^{0}C with prevailing wet conditions (Agrios, 2005). When tubers remain wet long enough, Tuber decay follow, resulting in further spread of the bacteria when tubers are graded (Pe´rombelon, 2002). For long term storage tubers can be dried rapidly by forced ventilation with warm air for wound healing, followed by cooler air to control sprouting for the duration of storage (Talib Sahi *et al*., 2007). Good seed storage management prevent tuber decay and avoid increasing the tuber inoculum load.

The variation observed remains likely to be due to size and physiological differences (Talib Sahi et al., 2007) among tubers. Mature tubers tend to have better developed periderm and thus resist injuries that can inoculate bacteria into the tuber flesh (Marquez-Villavicencio *et al*., 2011). Tubers develop at different times under potato plants and some of the tubers examined may be older than others, even though they are of the same size. However, calcium deficiency in particular might account for differences in susceptibility (Marquez-Villavicencio *et al*., 2011).

Greenhouse experiment: The transparent, circular, shining, raised and creamy white confirm that the isolates belong to *Pectobacterium* spp. and in particular *Pectobacterium carotovorum* subsp *carotovorum.* Infection of seed tubers by *Pectobacterium* species lead to the development of various symptoms during vegetative growth in the greenhouse. High emergence of the Diamond variety for both inoculated and un-inoculated tubers could be because of its early emergence characteristic which does not give the bacteria a chance to set before completely destroying the tubers underground. For Diamond variety, the plant vigour for the inoculated pots was slower than that of un inoculated pots but lesions were noticed on the leaves of the inoculated pots. For Mnandi, Amethyst, Montclare and BP1, emergence percentages was low to an extent that inoculated pots did not have any plants emerging

***Field experiment*:** The low crop emergence percentages across all varieties is an indication that the seed was affected latently by soft rot bacteria. According to Ngadze (2014), crop emergence and yield are affected by soft rot bacteria negatively. Disturbed plant physiology contributes to the tolerance levels of the crop to soft rot bacteria. Soft rot bacteria on its own cannot penetrate plant haulms (Perombelon, 2002) but it migrates on to insect damaged plant parts or takes advantage of lenticel openings and cracks. When the parent tuber rots, the bacteria are released into the soil and transmitted by the soil to contaminate neighboring progeny (Czajkowski *et al*. 2011b). Excess water from irrigation can easily transport soft rot infection throughout the whole field. The bacteria can colonize potato roots and subsequently move via the vascular system into progeny tubers. Once in the stem, the bacteria does not necessarily cause stem rots but will survive as latent infection in the tubers. According to Perombelon (2002), soft rot bacteria survival in the soil is restricted to one week to six months when the bacteria are in association with plant material including volunteers. It is possible that cultivars highly susceptible to soft rot may be prone to bacterial soft rot. The low yield from Amethyst could be attributed to the high incidence recorded on soft rot infected tubers as well as the high proportion of small sized tubers relative to the other varieties. Perombelon, (2002) noticed that shallow, light reddish -brown dry rot lesion caused by early blight develops to soft rot which develops and destroys the tuber rapidly.

Tuber size and maturity affect the susceptibility of potato tubers to soft rot (Marquez-Villavicencio *et al.,* 2011). Smaller tubers are less prone to handling damages than large tubers. The tubers of Mnandi, Amethyst and Montclare which were ranging from large to medium size were heavily infested with soft rot signifying that tuber size is a factor of concern when determining tolerance to soft rot.

CONCLUSION

BP1 is a variety which is more susceptible to soft rot bacteria among all varieties studied. Maximum hygiene is required when handling seed or throughout field operations so that soft rot incidence can be reduced to allow farmers to achieve high yields. It was noted that continuous use of potato seed results in the bacteria developing and getting accustomed to the variety resulting in high susceptibility levels to soft rot. The issue of crop rotation should not be ignored as small scale farmers have limited land and the bacteria develop over time in the soil. Diamond variety was more tolerant amongst all varieties studied and thus good yield. Other varieties that were uninoculated with the bacteria were still affected by soft rot showing that tubers with latent infection cannot be observed by the physical eye. However, crop emergence can be affected negatively if infected tubers are planted. Control measures which reduce bacterial contamination on seed tubers also reduce the risk of soft rot. BP1 may attain high yields in the field but in storage its response to soft rot infection is poor. A consideration of revising BP1 performance is necessary. We are recommending farmers to be encouraged, to adopt new cultivars and slowly get away with BP1 as it is more susceptible to soft rot infection in storage. New updated releases by breeders of improved cultivars would assist in soft rot management.

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